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Ballistic Resistant Protective Materials

NIJ Standard-0108.00

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Paul Cascarano, Assistant Director
National Institute of Justice

Technology Assessment Program

NIJ Standard for Ballistic Resistant Protective Materials

A Voluntary National Standard Promulgated by the National Institute of Justice.

December 1981

U.S. DEPARTMENT OF JUSTICE
National Institute of Justice

U.S. DEPARTMENT OF JUSTICE
National Institute of Justice

JAMES L. UNDERWOOD
Acting Director

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NIJ STANDARD
FOR
BALLISTIC RESISTANT PROTECTIVE MATERIALS

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FOREWORD

This document, NIJ Standard-0108.00, Ballistic Resistant Protective Materials, is an equipment standard developed by the Law Enforcement Standards Laboratory of the National Bureau of Standards. It is produced as part of the Technology Assessment Program of the National Institute of Justice. A brief description of the program appears on the inside front cover.

This standard is a technical document that specifies performance and other requirements equipment must meet to conform to the needs of criminal justice agencies for high quality service. Purchasers can use the test methods described in this report to determine firsthand whether a particular piece of equipment meets the standards, or they may have the tests conducted on their behalf by a qualified testing laboratory. Procurement officials may also refer to this standard in their purchasing documents and require that equipment offered for purchase meet the requirements, with compliance guaranteed by the vendor or attested to by an independent laboratory.

Because this NIJ standard is designed as a procurement aid, it is necessarily highly technical. For those who seek general guidance about the capabilities of ballistic resistant protective materials, user guides also are published. The guides explain in non-technical language how to select equipment capable of the performance required by an agency.

NIJ standards are subjected to continuing review. Technical comments and recommended revisions are welcome. Please send suggestions to the Program Manager for Standards, National Institute of Justice, U.S. Department of Justice, Washington, DC 20531.

Before citing this or any other NIJ standard in a contract document, users should verify that the most recent edition of the standard is used. Write to: Chief, Law Enforcement Standards Laboratory, National Bureau of Standards, Washington, DC 20234.

Lester D. Shubin
Program Manager for Standards
National Institute of Justice

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NIJ STANDARD FOR BALLISTIC RESISTANT PROTECTIVE MATERIALS

1. PURPOSE

The purpose of this standard is to establish minimum performance requirements and methods of test for ballistic resistant protective materials. This standard supersedes NILECJ-STD-0103.00, Portable Ballistic Shields, dated May 1974, by expanding the applicability of the standard to all materials used to provide ballistic protection against gunfire, including portable ballistic shields. In addition, this standard establishes threat level classifications that are consistent with other NIJ standards for ballistic protection.

2. SCOPE AND CLASSIFICATION

2.1 Scope

This standard is applicable to all ballistic resistant materials (armor) intended to provide protection against gunfire, with the exception of police body armor and ballistic helmets, which are the topic of individual NIJ performance standards [1,2]*. Many different types of armor are now available that range in ballistic resistance from those designed to protect against small caliber handguns to those designed to protect against high-powered rifles. Ballistic resistant materials are used to fabricate portable ballistic shields, such as a ballistic clipboard for use by a police officer, to provide ballistic protection for fixed structures such as critical control rooms or guard stations, and to provide ballistic protection for the occupants of vehicles. The ballistic resistant materials used to fabricate armor include metals, ceramics, transparent glazing, fabric, and fabric reinforced plastics; they are used separately or in combination, depending upon the intended weapon threat protection.

The ballistic threat posed by a bullet depends, among other things, on its composition, shape, caliber, mass, and impact velocity. Because of the wide variety of cartridges available in a given caliber, and because of the existence of hand loads, armors that will defeat a standard test round may not defeat other loadings in the same caliber. For example, an armor that prevents penetration by a 357 Magnum test round may or may not defeat a 357 Magnum round with higher velocity. Similarly, for identical striking velocities, non-deforming or armor piercing rounds pose a significantly greater penetration threat than an equivalent lead core round of the same caliber. The test ammunition specified in this standard represent common threats to the law enforcement community.

2.2 Classification

Ballistic resistant protective materials covered by this standard are classified into five types, by level of performance.

2.2.1 Type I (22 LR—38 Special)

This armor protects against the standard test rounds as defined in paragraph 5.2.1. It also provides protection against lesser threats such as 12 gauge No. 4 lead shot and most handgun rounds in calibers 25 and 32.

2.2.2 Type II-A (Lower Velocity 357 Magnum—9 mm)

This armor protects against the standard test rounds as defined in paragraph 5.2.2. It also provides protection against most lesser threats such as 12 gauge 00 buckshot, 45 Auto., 22 caliber Long Rifle High Velocity (rifle), High

*Numbers in brackets refer to the references in appendix A.

Velocity 38 Special and some other factory loads in caliber 357 Magnum and 9 mm, as well as the threats mentioned in paragraph 2.2.1.

2.2.3 Type II (Higher Velocity 357 Magnum—9 mm)

This armor protects against the standard test rounds as defined in paragraph 5.2.3. It also provides protection against most lesser threats such as 12 gauge 00 buckshot, 45 Auto., 22 caliber Long Rifle High Velocity (rifle), High Velocity 38 Special and most other factory loads in caliber 357 Magnum and 9 mm, as well as the threats mentioned in paragraph 2.2.1.

2.2.4 Type III (High-Powered Rifle)

This armor protects against the standard test round as defined in paragraph 5.2.4. It also provides protection against most lesser threats such as 223 Remington (5.56 mm FMJ), 30 Carbine FMJ, and 12 gauge rifled slug, as well as the threats mentioned in paragraphs 2.2.1, 2.2.2 and 2.2.3.

2.2.5 Type IV (Armor Piercing Rifle)

This armor protects against the standard test round as defined in paragraph 5.2.5. It also provides at least single hit protection against the threats mentioned in paragraphs 2.2.1, 2.2.2, 2.2.3 and 2.2.4.

2.2.6 Special Type

A purchaser having a special requirement for a level of protection other than one of the above standards should specify the exact test rounds to be used, and indicate that this standard shall govern in all other respects.

3. DEFINITIONS

3.1 Angle of Incidence

The angle between the line of flight of the bullet and the perpendicular to the plane tangent to the point of impact (see fig. 1).

3.2 Fair Hit

A bullet that impacts the ballistic resistant protective material at an angle of incidence no greater than 5°, no closer to the edge of the test specimen or to a prior hit than 5 cm (2 in), and at an acceptable velocity as defined in this standard. A bullet that impacts too close to the edge or a prior hit and/or at too high a velocity, but does not penetrate, shall be considered a fair hit for the determination of penetration.

3.3 Full Metal Jacketed Bullet (FMJ)

A bullet made of lead completely covered, except for the base, with copper alloy (approximately 90 copper-10 zinc).

3.4 Jacketed Soft Point (JSP)

A bullet made of lead completely covered, except for the point, with copper alloy (approximately 90 copper-10 zinc).

3.5 Lead Bullet

A bullet made of lead alloyed with hardening agents.

3.6 Penetration

Perforation of a witness plate by any part of the test specimen or test bullet as determined by passage of light when held up to a 60-W light bulb.

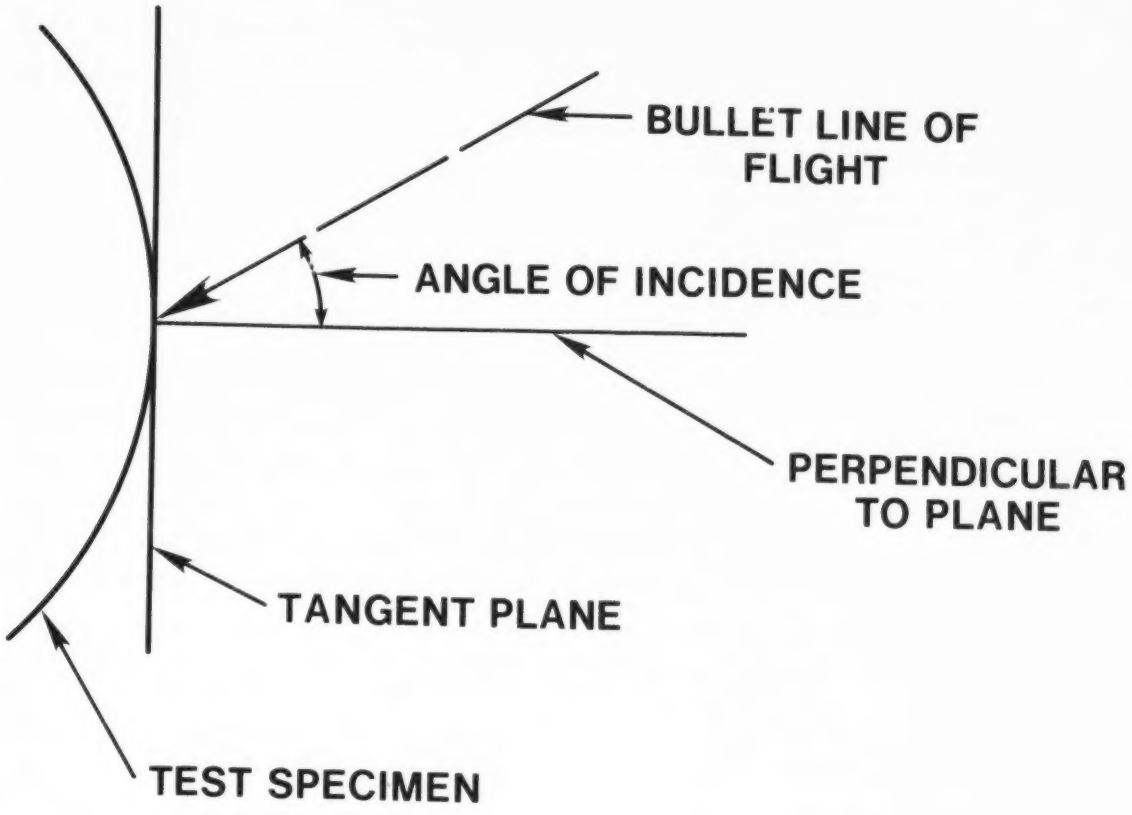

FIGURE 1. Angle of incidence.

3.7 Strike Face

The surface of a ballistic resistant protective material designated by the manufacturer as the surface that should be exposed to (face) the weapon threat.

3.8 Witness Plate

A thin sheet of aluminum alloy placed behind a test specimen to determine the potential for an incapacitating injury.

4. REQUIREMENTS

4.1 Ballistic Resistance

The ballistic resistance of each test specimen of ballistic resistant protective material shall be determined in accordance with paragraph 5.3. The test weapon and ammunition used during this test shall be those specified in table I in accordance with the type (threat level rating) specified by the manufacturer (par. 4.3). Any penetration of the witness plate shall constitute failure.

The ballistic resistance test variables and test requirements are presented in table I.

4.2 Workmanship

Ballistic resistant protective materials shall be free from dents, blisters, cracks, crazing, chipped or sharp corners, and other evidences of inferior workmanship.

TABLE 1. *Test summary*

Armor type	Test ammunition	Test variables: Nominal bullet mass	Test variables: Suggested barrel length	Test variables: Required bullet velocity	Performance requirements: Required fair hits per armor part	Performance requirements: Permitted penetrations
I	22 LRHV Lead	2.6 g 40 gr	15 to 16.5 cm 6 to 6.5 in	320±12 m/s 1050±40 ft/s	5	0
	38 Special RN Lead	10.2 g 158 gr	15 to 16.5 cm 6 to 6.5 in	259±15 m/s 850±50 ft/s	5	0
II-A	357 Magnum JSP	10.2 g 158 gr	10 to 12 cm 4 to 4.75 in	381±15 m/s 1250±50 ft/s	5	0
	9 mm FMJ	8.0 g 124 gr	10 to 12 cm 4 to 4.75 in	332±15 m/s 1090±50 ft/s	5	0
II	357 Magnum JSP	10.2 g 158 gr	15 to 16.5 cm 6 to 6.5 in	425±15 m/s 1395±50 ft/s	5	0
	9 mm FMJ	8.0 g 124 gr	10 to 12 cm 4 to 4.75 in	358±15 m/s 1175±50 ft/s	5	0
III	7.62 mm (308 Winchester) FMJ	9.7 g 150 gr	56 cm 22 in	873±46 m/s 2863±151 ft/s	5	0
IV	7.62 mm AP	9.7 g 150 gr	56 cm 22 in	851±15 m/s 2800±50 ft/s	1	0

Abbreviations:
AP—Armor Piercing
FMJ—Full Metal Jacketed
JSP—Jacketed Soft Point
LRHV—Long Rifle High Velocity
RN—Round Nose

4.3 Marking

Each ballistic resistant protective material shall be supplied with complete warranty information and shall be clearly marked with the manufacturer's name, limitations, brand name or logo, month and year of manufacture, the model number, and the type of protection provided according to section 2 of this standard.

5. TEST METHODS

5.1 Sampling Unit

The test specimen shall consist of a 30.5×30.5 cm (12×12 in) sample of the ballistic resistant material.

5.2 Test Equipment

It should be noted that hand-loaded ammunition may be required to achieve some of the bullet velocities required in the following paragraphs.

5.2.1 Type I Test Weapons and Ammunition

5.2.1.1 22 LR

The test weapon may be a 22 caliber handgun or test barrel. The use of a handgun with a 15 to 16.5 cm (6 to 6.5 in) barrel is suggested. Test bullets shall be 22 Long Rifle High Velocity lead, with nominal masses of 2.6 g (40 gr) and measured velocities of 320±12 m (1050±40 ft) per second.

5.2.1.2 38 Special

The test weapon may be a 38 Special handgun or test barrel. The use of a handgun with a 15 to 16.5 cm (6 to 6.5 in) barrel is suggested. Test bullets shall be 38 Special round-nose lead, with nominal masses of 10.2 g (158 gr) and measured velocities of 259±15 m (850±50 ft) per second.

5.2.2 Type II-A Test Weapons and Ammunition

5.2.2.1 Lower Velocity 357 Magnum

The test weapon may be a 357 Magnum handgun or test barrel. The use of a handgun with a 10 to 12 cm (4 to 4.75 in) barrel is suggested. Test bullets shall be 357 Magnum jacketed soft point, with nominal masses of 10.2 g (158 gr) and measured velocities of 381±15 m (1250±50 ft) per second.

5.2.2.2 Lower Velocity 9 mm

The test weapon may be a 9 mm handgun or test barrel. The use of a handgun with a 10 to 12 cm (4 to 4.75 in) barrel is suggested. Test bullets shall be 9 mm full metal jacketed, with nominal masses of 8.0 g (124 gr) and measured velocities of 332±15 m (1090±50 ft) per second.

5.2.3 Type II Test Weapons and Ammunition

5.2.3.1 Higher Velocity 357 Magnum

The test weapon may be a 357 Magnum handgun or test barrel. The use of a handgun with a 15 to 16.5 cm (6 to 6.5 in) barrel is suggested. Test bullets shall be 357 Magnum jacketed soft point, with nominal masses of 10.2 g (158 gr) and measured velocities of 425±15 m (1395±50 ft) per second.

5.2.3.2 Higher Velocity 9 mm

The test weapon may be a 9 mm handgun or test barrel. The use of a handgun with a 10 to 12 cm (4 to 4.75 in) barrel is suggested. Test bullets shall be 9 mm full metal jacketed, with nominal masses of 8.0 g (124 gr) and measured velocities of 358±15 m (1175±50 ft) per second.

5.2.4 Type III Test Weapon and Ammunition

The test weapon may be a rifle or a test barrel chambered for 7.62 mm (308 Winchester) ammunition. The use of a rifle with a barrel length of 56 cm (22 in) is suggested. Test bullets shall be 7.62 mm full metal jacketed (U.S. military designation M80), with nominal masses of 9.7 g (150 gr) and measured velocities of 873±46 m (2863±151 ft) per second.

5.2.5 Type IV Test Weapon and Ammunition

The test weapon may be a rifle or a test barrel chambered for caliber 7.62 mm ammunition. The use of a rifle with a barrel length of 56 cm (22 in) is suggested. Test bullets shall be caliber 7.62 mm armor piercing (U.S. military designation APM61), with nominal masses of 9.7 g (150 gr) and measured velocities of 851±15 m (2800±50 ft) per second.

5.2.6 Chronograph

The chronograph shall have a precision of 1 μs and an accuracy of 2 μs. Its triggering devices shall be of either the photoelectric or conductive screen type.

5.2.7 Support Fixture

The test specimen shall be supported by a fixture that permits its position and attitude to be readily adjusted so that it is perpendicular to the line of flight of the bullet at the point of impact.

5.2.8 Witness Plate

The witness plate shall be a 0.5 mm (0.020 in) thick sheet of 2024-T3 or 2024-T4 aluminum alloy and shall be placed and rigidly affixed perpendicular to the line of flight of the bullet and 15 cm (6 in) beyond the armor under test.

5.3 Test Procedure

Condition the test specimen at a temperature of 20 to 28 °C (68 to 82 °F) for at least 24 h prior to test.

Place the triggering devices 2 and 3 m (6.6 and 9.8 ft), respectively, from the muzzle of the test weapon as shown in figure 2, and arrange them so that they define planes perpendicular to the line of flight of the bullet. Measure the distance between them with an accuracy of 1.0 mm (0.04 in). Use the time of flight and distance measurements to calculate the velocity of each test round.

After the specified test weapon has been supported, leveled and positioned, fire one or more pre-test rounds (as needed) through a witness plate to determine the point of impact.

Place the test specimen in the support fixture and position it 5 m (16 ft) from the muzzle of the test weapon. Then position an unperforated witness plate 15 cm (6 in) beyond the test specimen. Fire a test round and record the time of flight of the bullet as measured by the chronograph. Examine the witness plate to determine penetration, and examine the specimen to see if the bullet made a fair hit.

If no penetration occurred, reposition the test specimen or position another specimen (as required) and repeat the procedure with additional test rounds until the test is completed. Space the hits as evenly as possible so that every portion of the test specimen is subject to test.

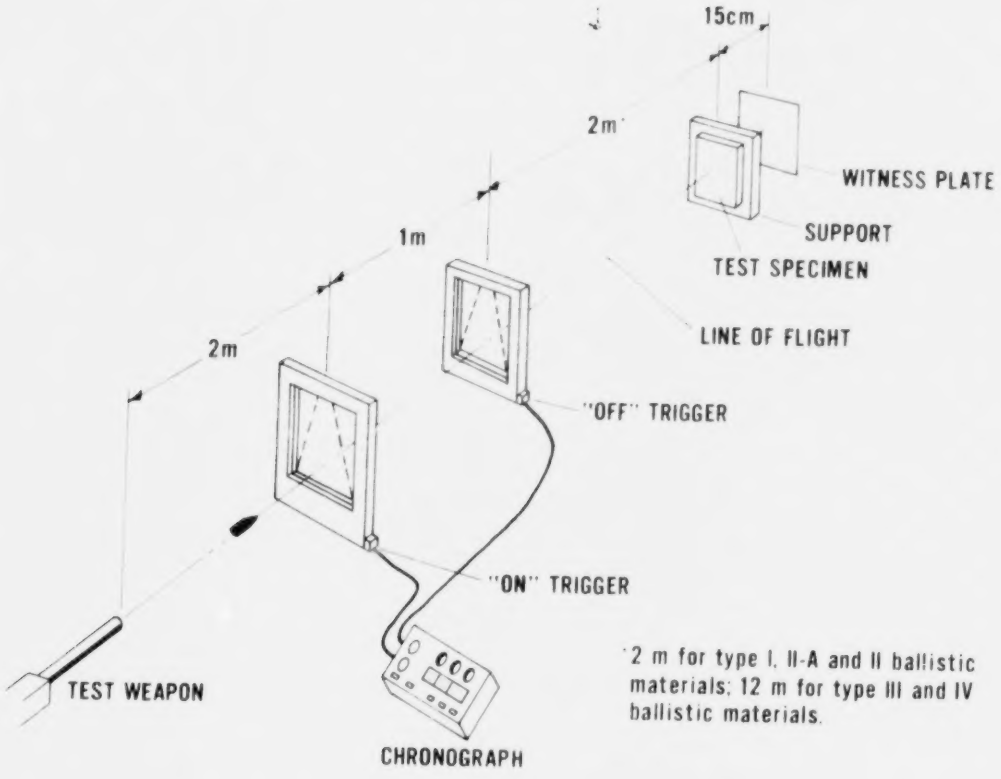

FIGURE 2. Ballistic test setup.

APPENDIX A—REFERENCES

1. NILECJ-STD-0101.01, "The Ballistic Resistance of Police Body Armor," National Institute of Justice, U.S. Department of Justice, Washington, DC 20531 (Dec. 1978).
2. NIJ Standard-0106.01, "Ballistic Helmets," (in preparation).

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